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Description

FIELD

[0001] The present disclosure is related to a method of coating a field joint for insulated pipelines, pipe sections for forming such coated field joints, and pipelines having such coated field joints. The present disclosure may be relevant to onshore and/or offshore, oil and gas pipelines.

BACKGROUND

[0002] Typically, pipe sections which are factory-coated with an elastomer and/or insulation coating are not fully coated along their entire lengths, but rather are left with uncoated ends to facilitate joining of the pipe section ends (e.g., using a welding process) in the field. Each uncoated end on a pipe section may be about 200mm in length. The pipe sections are typically welded together as part of the pipe laying process. This welding may take place at the location where the pipe sections are to be reeled, or, such as in the case of sub-sea or offshore pipes, on a lay barge or a reel ship.

[0003] After welding, the field joint should be coated. The field joint coating is typically an insulation material that is typically different than, but having similar properties as, the parent coating provided on the pipe section at the factory. For the purpose of speed and ease, the field joint coating is typically applied using an injection moulding process in which the field joint coating is injected into a mould placed about the field joint and overlapping with the parent coating.

[0004] The result is typically a coated field joint as shown in the longitudinal cross-sectional view of FIG. 1. For simplicity, only the upper half of the cross-sectional view is shown, however it should be understood that the bottom half of the cross-sectional view is a mirror of the shown half. This example illustrates a field joint between two pipe sections A and B, each having factory-applied parent coatings C_A and C_B, respectively. The field joint coating D typically fills in the gap between the parent coatings C_A and C_B, and also overlaps the parent coatings C_A and C_B. This overlap means that the field joint coating D has a greater radius than the parent coatings C_A and C_B, and this difference is referred to as the upstand E. In a typical coated field joint, the upstand may be 8mm or greater. The presence of a large upstand (e.g., an upstand that is 8mm or greater) may cause damage to pipe handling equipment and/or the field joint, such as when the field joint is reeled out over rollers during laying of the pipeline.

[0005] PCT international patent application published as WO 2012/168149 A1 discloses a process for coating a field joint. Two pipes, which are coated with an epoxy layer, an adhesive layer and polypropylene layers are provided. Cut backs are provided on the epoxy layer, the adhesive layer and the polypropylene layers. The ends of pipes are welded together, forming a field joint. The field joint is coated with an epoxy layer and an adhesive layer and a field joint coating is then applied to the coated field joint and the cut back.

[0006] PCT international patent application published as WO 2013/066170 A1 discloses a method for coating a field joint. The pipes are coated with a layer of anti-corrosion agent and a layer of coating. Cut backs are provided on each layer. The cut back in the anti-corrosion agent layer is perpendicular to the surface of the pipe, while the cut back in the coating layer is angular. After the pipes are joined, a coating layer is applied at the pipe joint, covering the field joint and the cut backs.

[0007] The present invention is defined in independent claim 1. Preferred or advantageous features of the present invention are defined in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Reference will now be made, by way of example, to the accompanying drawings which show example embodiments of the present application, and in which:

FIG. 1 shows a longitudinal cross-sectional view of a typical conventional coated field joint;

FIG. 2 shows a longitudinal cross-sectional view of an example coated field joint in accordance with an example of the present disclosure;

FIG. 3 shows a perspective view of an end of a pipe section after cut backs are provided to the parent coating, in accordance with an example of the present disclosure;

FIG. 4 shows a side view of the pipe section end of FIG. 3; and

FIG. 5 shows an end-on view of the pipe section end of FIG. 3.

[0009] Similar reference numerals may have been used in different figures to denote similar components.

DESCRIPTION OF EXAMPLE EMBODIMENTS

[0010] In some examples, the present disclosure provides a method of coating a field joint joining uncoated ends of two pipe sections, each pipe section being coated with a parent coating and having at least one uncoated end, the method including: providing a first angular cut back in the parent coating of each pipe section, the first angular cut back being at an angle of about 30° ± 5° relative to a longitudinal axis of the field joint; providing a second angular cut back in the parent coating of each pipe section, the second angular cut back being positioned further from the field joint than the first angular cut back; the first and second angular cut backs resulting in the parent coating having a stepped profile, a step in the

stepped profile being defined between the first and second angular cut backs, the step being substantially parallel to the longitudinal axis of the field joint and being free of indentations; and injection moulding a field joint coating over the uncoated ends and the first and second angular cut backs, the field joint coating being moulded to have an upstand that is less than or equal to about 5mm.

[0011] In some examples, the present disclosure provides a pipe section for forming a field joint, the pipe section including: a pipe section end to be joined with another pipe section end for forming the field joint; and a parent coating over an outer surface of the pipe section, the outer surface in the vicinity of the pipe section end being free of the parent coating; the parent coating in the vicinity of the pipe section end having provided therein first and second angular cut backs, the first angular cut back being at an angle of between 20° and 45° with a manufacturing tolerance of +/- 5°, for example, about 30° $\pm$ 5°, relative to a longitudinal axis of the pipe section and the second angular cut back being positioned further from the pipe section end than the first angular cut back; the first and second angular cut backs resulting in the parent coating having a stepped profile, a step in the stepped profile being defined between the first and second angular cut backs, the step being substantially parallel to the longitudinal axis of the pipe section and being free of indentations.

[0012] In some examples, the present disclosure provides a coated field joint joining ends of two pipe sections, the coated field joint including: a field joint joining the ends of the two pipe sections, each of the two pipe sections being as described above; and a field joint coating over the field joint and the first and second angular cut backs, the field joint coating forming an upstand that is less than or equal to about 5mm.

[0013] The present disclosure provides methods for coating a field joint, coated field joints formed thereby and pipe sections for forming such coated field joints. The coated field joint in accordance with the present disclosure may achieve an upstand that is substantially flush with the parent coating on the pipe section, or that is minimal (e.g., 5mm or less). The present disclosure may enable a coated field joint that uses a smaller volume of field joint coating material. A field joint that is flush with the parent coating or that has a reduced upstand may enable easier handling in the yard and/or on the vessel prior to laying of the pipe, may help to reduce the risk of damage to laying equipment (e.g., tensioners on reel-lay vessels), and/or may enable more pipe to be reeled (due to the smaller diameter of the disclosure coated field joint, compared to conventional coated field joint).

[0014] FIG. 2 shows a cross-sectional view of a coated field joint in accordance with an example of the present disclosure. In this example, two pipe sections 2, 4 are joined together at their respective ends 6, 8. For simplicity, details will be described only for one side of the field joint corresponding to pipe section 2, however it should be understood that the configuration is the same for the other side of the field joint corresponding to pipe section 4.

[0015] The pipe section 2 is provided with a parent coating 10, which may have been applied at a manufacturing site, such as a factory. The parent coating 10 may be any thermoplastic or thermosetting material. The parent coating 10 may be a multi-layered coating. For example, the parent coating 10 may include an inner anti-corrosion layer (e.g., a polyurethane or epoxy layer), a middle insulation layer (e.g., a foamed or unfoamed polypropylene layer) and an outer protective layer (e.g., an unfoamed polypropylene, polyurethane, epoxy resin or rubber layer). Different single-layered or multi-layered coatings may be used for the parent coating 10. For simplicity, the parent coating 10 is illustrated without showing different layers. The parent coating 10, as initially applied at the factory, may leave the end 6 of the pipe section 2 uncoated, for example about 200mm from each end of the pipe section 2 may be free of the parent coating 10. The parent coating 10 may end abruptly or gradually (e.g., taper off) near the ends of the pipe section 2.

[0016] Initially, the field joint is formed by joining (e.g., by welding) the uncoated ends 6, 8 of the pipe sections 2, 4. Initially, the pipe sections 2, 4 in the vicinity of the joint are uncoated. The joint may be coated by a field joint coating, as described below. Prior to application of the field joint coating, cut backs may be made in the parent coating 10, as described below.

[0017] As shown in FIG. 2, a first angular cut back 102 is provided in the parent coating 10. The first cut back 102 may be made using any suitable technique, such as by a grinding process or a lathing method. The first cut back 102 is provided at an angle x relative to the longitudinal axis L of the field joint (which may also be the longitudinal axis of the pipe sections 2, 4). The first cut back 102 is provided about the entire circumference of the pipe section 2, resulting in a frustoconical shape (see FIG. 3).

[0018] A second angular cut back 104 is provided in the parent coating 10. The second cut back may be made using any suitable technique (which may be the same or different from that used for the first cut back 102), such as by a grinding process or a bevelling method. The second cut back 104 is provided further away from the end 6 than the first cut back 102, resulting in a stepped profile, as shown in the cross-sectional view of FIG. 2. The second cut back 104 is provided at an angle y relative to the longitudinal axis L of the field joint. The angle y may be the same as or different from the angle x of the first cut back 102. The second cut back 104 is provided about the entire circumference of the pipe section 2 (see FIG. 3).

[0019] While the first cut back 102 is made through the entire thickness of the parent coating 10, the second cut back 104 is made to a depth h_2 that is less than the entire thickness of the parent coating 10. In a longitudinal cross-section, as shown in FIG. 2, the first and second cut backs 102, 104 form a stepped profile, with the first cut back 102

forming an incline at an angle x to a height of h_1, the second cut back 104 forming an incline at an angle y to a height of h_2, and a step 106 of length l_1, substantially parallel to the longitudinal axis L, being defined between the first and second cut backs 102, 104. The surface of the step 106 is substantially free of indentations or grooves. Further details about the dimensions of the cut backs 102, 104 are described below.

[0020] After the first and second cut backs 102, 104 are provided in the parent coating 10, a field joint coating 108 may be injection moulded over the uncoated ends 6, 8 and the first and second cut backs 102, 104. The field joint coating 108 may be any suitable material, including any thermoplastic or thermosetting material typically known and used for such applications, for example including an insulation material similar to or same as the insulation layer of the parent coating 10 (e.g., a foamed or unfoamed polypropylene material). Other materials may be suitable for the field joint coating 108, including materials suitable for high temperature applications. The field joint coating 108 may extend past the second cut back 104 and cover the parent coating 10 to a distance l_2, and may have an upstand 110 of less than or equal to about 5mm. In some examples, the upstand 110 may be substantially 0mm (in which case the distance l_2 may be substantially 0mm).

[0021] In order to injection mould the field joint coating 108, a mould (not shown) may be positioned about the first and second cut backs 102, 104 on both pipe sections 2, 4 and including the welded field joint. The field joint coating 108 may be injected into the mould. The injection moulding process may be carried out at a sufficient temperature and/or pressure to ensure that the field joint coating 108 fully fills in the mould and fully covers the exposed surfaces of the pipe sections 2, 4, the cut backs 102, 104, and the step 106 (and optionally a portion of the parent coating 10 to a distance l_2). The mould may be preheated, for example to about 70°C, which may help with setting and/or curing of the field joint coating 108. The mould may be removed after the field joint coating 108 has set and/or cured. In some examples, the mould may be removed when the field joint coating 108 is partly or mostly set and/or cured, and full setting and/or curing of the field joint coating 108 may occur without the mould.

[0022] In some examples, the exposed surfaces of the first and second cut backs 102, 104 and the step 106 (and optionally uncut portions of the parent coating 10 near the second cut back 104 that may be coated by the field joint coating 108) may be pre-treated prior to injection moulding the field joint coating 108. For example, one or more such surfaces may be cleaned (e.g., using a solvent, such as xylene). In some examples, exposed metal surfaces of the pipe sections 2, 4 in the vicinity of the welded field joint may be heated (e.g., using an induction heating coil), such as to a temperature in the range of about 70°C to about 90°C. A primer, which may improve binding of the field joint coating 108, may be applied to the heated or unheated metal surfaces. In some examples, exposed surfaces of the first and second cut backs 102, 104 and the step 106 (and optionally uncut portions of the parent coating 10 near the second cut back 104 that may be coated by the field joint coating 108) may be abraded (e.g., using a grinder). The surfaces of the first and second cut backs 102, 104 and the step 106 (and optionally uncut portions of the parent coating 10 near the second cut back 104 that may be coated by the field joint coating 108) may be flame treated and may be coated with a primer. The entire area to be coated by the field joint coating 108 may be flame treated and/or primed with a primer. One or more of these pre-treatments may be used in combination. The pre-treatments may help the field joint coating 108 to better bond to the exposed surfaces of the pipe sections 2, 4, the cut backs 102, 104, and the step 106.

[0023] In some examples, after the field joint coating 108 has been applied, a quality check may be performed to ensure that the upstand 110 is within acceptable values (e.g., less than or equal to 5mm).

[0024] Further details of the cut backs 102, 104 are now described with reference to FIGS. 3-5. For simplicity, these figures illustrate the cut backs 102, 104 for one pipe section 2, prior to injection of the field joint coating 108. For simplicity, the parent coating 10 is shown as a uniform single layer, however it should be understood that the parent coating 10 may be multi-layered.

[0025] The first cut back 102 may be provided at an angle x, which is between 20° and 45° with a manufacturing tolerance of +5°/-5° and in certain embodiments may be about 30° $\pm$ 5° relative to the longitudinal axis L. The second cut back 104 may be provided at an angle y, which may, in certain embodiments, also be between 20° and 45° with a manufacturing tolerance of +5°/-5° and in certain embodiments about 30° $\pm$ 5° relative to the longitudinal axis L, or may be different.

[0026] The second cut back 104 may be set back from the first cut back 102, such that the step 106, in profile, has a length l_1 of up to 50mm.

[0027] In profile, the second cut back 104 can have any height h_2 that is greater than or equal to 8mm. Of course, one can appreciate that the height h_1 of the first cut back is equal to the thickness of the parent coating 10, minus h_2.

[0028] The outer diameter of the pipe is typically between 150 mm and 500 mm.

[0029] Referring back to FIG. 2, the field joint coating 108 may extend over the uncut parent coating for a length l_2 , typically less than 60 mm but desirably about 50 mm or less. As explained above, where the upstand is 0mm, by definition, l_2 would be 0.

[0030] In some cases, although reducing the upstand 110 may help to reduce risk of damage to the coated field joint and/or pipe-laying equipment, it may be necessary to have a small amount of upstand 110 (i.e., less than or equal to 5mm). The presence of a small upstand 110 may be required depending on mould tolerances, application conditions, etc. This small amount of upstand 110 may

still be sufficient to avoid or reduce the disadvantages of a large upstand E, as discussed with respect to FIG. 1 above.

[0031] Although the cut backs have been described as being provided in the parent coating after the field joint is welded, in some examples the cut backs may be provided in the parent coating before welding the field joint. For example, the cut backs may be provided at a manufacturing site, rather than on site or on the reel-lay vessel. This may be useful to help reduce the time needed for handling and laying the pipeline at the site. Where the cut backs are provided offsite, one or more pre-treating steps, such as those described above, may also be performed offsite (e.g., at the same or a different manufacturing site). In examples where the ends of the pipe sections have been pre-treated offsite, the pre-treated ends may be protected (e.g., wrapped with sheet plastic) to help retain the integrity of the treated field joint area. The protective sheet plastic may expose the pipe section ends, to allow the field joint to be welded, while protecting the pre-treated cut back surfaces. When the welding is complete and the field joint coating is to be moulded, the protective sheet plastic may then be removed, any additional pre-treatment steps may be carried out, and the field joint coating may be injection moulded over the field joint. By providing the cut backs offsite (and optionally one or more pre-treatment steps offsite), the time for processing and laying of the pipeline onsite may be reduced. Further, the amount of equipment needed onsite may be reduced. Performing these steps offsite may also enable more rigorous quality checking and testing.

[0032] The present disclosure includes methods for forming the coated field joint, as well as the coated field joint formed thereby. The present disclosure may also include pipe sections in which the first and second cut backs have been made in the parent coating, prior to or after welding of the field joint.

[0033] The angles of the cut backs and the length of the step between the first and second cut backs may be designed for better adhesion between the field joint coating and the parent coating, and to help reduce unwanted detachment of the field joint coating from the parent coating, such as when the coated field joint is bent or otherwise handled.

Claims

1. A method of coating a field joint joining uncoated ends (6,8) of two pipe sections (2, 4), each pipe section being coated with a parent coating (10) and having at least one uncoated end (6, 8), the method comprising:

   providing a first angular cut back (102) in the parent coating (10) of each pipe section (2, 4), the first angular cut back (102) being at an angle of between 20° and 45°, preferably about 30°, with a manufacturing tolerance of +5°/-5°, relative to a longitudinal axis of the field joint;
   providing a second angular cut back (104) in the parent coating (10) of each pipe section (2, 4), the second angular cut back (104) being positioned further from the field joint than the first angular cut back (102);
   the first and second angular cut backs (102, 104) resulting in the parent coating having a stepped profile, a step (106) in the stepped profile being defined between the first and second angular cut backs (102, 104), the step (106) being substantially parallel to the longitudinal axis of the field joint and being free of indentations; and
   injection moulding a field joint coating (108) over the uncoated ends (6, 8) and the first and second angular cut backs (102, 104), the field joint coating being moulded to have an upstand (110) that is less than or equal to about 5mm, preferably about 0mm.

2. The method of claim 1 wherein the second angular cut back (104) is at an angle of between 20° and 45°, preferably about 30°, with a manufacturing tolerance of +5°/-5°, relative to the longitudinal axis of the field joint.

3. The method of claim 1 wherein the field joint coating (108) is injection moulded polypropylene.

4. The method of claim 1, wherein, in the stepped profile, the step (106) between the first and second cut backs (102, 104) has a length of about 50mm.

5. The method of claim 1 wherein the second cut back (104) is at a depth in the range of about 10mm to about 15mm.

6. The method of claim 1 wherein the first and second cut backs (102, 104) are provided in the parent coating (10) by a grinding process or a lathing method.

7. The method of claim 1 further comprising positioning a mould about the first and second cut backs (102, 104), and injecting moulding the field joint coating (108) into the mould.

8. The method of claim 1 further comprising pre-treating exposed surfaces of the field joint prior to injection moulding the field joint coating (108), wherein the pre-treating preferably comprises at least one of cleaning the surfaces, heating the surfaces, abrading the surfaces, and applying a primer to the surfaces.

Patentansprüche

1. Verfahren zur Beschichtung einer Rohrverbindung vor Ort, die unbeschichtete Enden (6, 8) von zwei Rohrabschnitten (2, 4) aneinanderfügt, wobei jeder Rohrabschnitt mit einer Hauptbeschichtung (10) beschichtet ist und mindestens ein unbeschichtetes Ende (6, 8) aufweist, wobei das Verfahren Folgendes umfasst:

   Bereitstellen eines ersten schrägen Rückschnitts (102) in der Hauptbeschichtung (10) jedes Rohrabschnitts (2, 4), wobei der erste schräge Rückschnitt (102) einen Winkel zwischen 20° und 45°, vorzugsweise etwa 30°, mit einer Fertigungstoleranz von +5°/-5°, relativ zu einer Längsachse der Rohrverbindung hat;
   Bereitstellen eines zweiten schrägen Rückschnitts (104) in der Hauptbeschichtung (10) jedes Rohrabschnitts (2, 4), wobei der zweite schräge Rückschnitt (104) weiter von der Rohrverbindung positioniert ist als der erste schräge Rückschnitt (102);
   wobei der erste und der zweite schräge Rückschnitt (102, 104) dazu führen, dass die Hauptbeschichtung ein gestuftes Profil aufweist, wobei eine Stufe (106) in dem gestuften Profil zwischen dem ersten und dem zweiten schrägen Rückschnitt (102, 104) definiert ist, wobei die Stufe (106) im Wesentlichen parallel zur Längsachse der Rohrverbindung ist und frei von Einbuchtungen ist; und
   Spritzgießen einer Rohrverbindungsbeschichtung (108) auf die unbeschichteten Enden (6, 8) und den ersten und den zweiten schrägen Rückschnitt (102, 104), wobei die Rohrverbindungsbeschichtung so geformt wird, dass sie eine Aufkantung (110) aufweist, die kleiner als oder gleich 5 mm ist, vorzugsweise etwa 0 mm.

2. Verfahren nach Anspruch 1, wobei der zweite schräge Rückschnitt (104) einen Winkel zwischen 20° und 45°, vorzugsweise etwa 30°, mit einer Fertigungstoleranz von +5°/-5° relativ zur Längsachse der Rohrverbindung hat.

3. Verfahren nach Anspruch 1 wobei die Rohrverbindungsbeschichtung (108) spritzgegossenes Polypropylen ist.

4. Verfahren nach Anspruch 1, wobei bei dem gestuften Profil die Stufe (106) zwischen dem ersten und dem zweiten Rückschnitt (102, 104) eine Länge von etwa 50 mm hat.

5. Verfahren nach Anspruch 1, wobei der zweite Rückschnitt (104) auf einer Tiefe im Bereich von etwa 10 mm bis etwa 15 mm liegt.

6. Verfahren nach Anspruch 1, wobei der erste und der zweite Rückschnitt (102, 104) in der Hauptbeschichtung (10) durch einen Schleifprozess oder ein Drehverfahren bereitgestellt werden.

7. Verfahren nach Anspruch 1, das ferner das Positionieren einer Form um den ersten und den zweiten Rückschnitt (102, 104) und Spritzgießen der Rohrverbindungsbeschichtung (108) in der Form umfasst.

8. Verfahren nach Anspruch 1, das ferner das Vorbehandeln freiliegender Oberflächen der Rohrverbindung vor dem Spritzgießen der Rohrverbindungsbeschichtung (108) umfasst, wobei das Vorbehandeln vorzugsweise mindestens eines von dem Reinigen der Oberflächen, Erwärmen der Oberflächen, Abschleifen der Oberflächen und Auftragen einer Grundierung auf die Oberflächen umfasst.

Revendications

1. Procédé de revêtement d'un joint de montage raccordant des extrémités non revêtues (6, 8) de deux sections de tuyau (2, 4), chaque section de tuyau étant revêtue d'un revêtement parent (10) et présentant au moins une extrémité non revêtue (6, 8), le procédé comprenant :

   la réalisation d'une première coupe angulaire (102) dans le revêtement parent (10) de chaque section de tuyau (2, 4), la première coupe angulaire (102) étant pratiquée à un angle entre 20° et 45°, de préférence environ 30°, avec une tolérance de fabrication de +5°/-5° par rapport à un axe longitudinal du joint de montage ;
   la réalisation d'une seconde coupe angulaire (104) dans le revêtement parent (10) de chaque section de tuyau (2, 4), la seconde coupe angulaire (104) étant positionnée plus loin du joint de montage que la première coupe angulaire (102) ;
   les première et seconde coupes angulaires (102, 104) amenant le revêtement parent à avoir un profil à gradins, un gradin (106) dans le profil à gradins étant défini entre les première et seconde coupes angulaires (102, 104), le gradin (106) étant sensiblement parallèle à l'axe longitudinal du joint de montage et étant exempt d'indentations ;
   le moulage par injection d'un revêtement de joint de montage (108) sur les extrémités non revêtues (6, 8) et les première et seconde coupes angulaires (102, 104), le revêtement de joint de montage étant moulé de manière à avoir un prolongement (110) inférieur ou égal à environ 5 mm, de préférence environ 0 mm.

2. Procédé selon la revendication 1, dans lequel la seconde coupe angulaire (104) est pratiquée à un angle entre 20° et 45°, de préférence environ 30°, avec une tolérance de fabrication de +5°/-5°, par rapport à l'axe longitudinal du joint de montage.

3. Procédé selon la revendication 1, dans lequel le revêtement de joint de montage (108) est en polypropylène moulé par injection.

4. Procédé selon la revendication 1, dans lequel, dans le profil à gradins, le gradin (106) entre les première et seconde coupes angulaires (102, 104) a une longueur d'environ 50 mm.

5. Procédé selon la revendication 1, dans lequel la seconde coupe (104) est pratiquée à une profondeur d'environ 10 mm à environ 15 mm.

6. Procédé selon la revendication 1, dans lequel les première et seconde coupes (102, 104) sont réalisées dans le revêtement parent (10) par un procédé de meulage ou un procédé de tournage.

7. Procédé selon la revendication 1, comprenant en outre le positionnement d'un moule autour des première et seconde coupes (102, 104), et le moulage par injection du revêtement de joint de montage (108) dans le moule.

8. Procédé selon la revendication 1, comprenant en outre le prétraitement de surfaces exposées du joint de montage avant le moulage par injection du revêtement de joint de montage (108), dans lequel le prétraitement comprend de préférence au moins l'un d'un nettoyage des surfaces, d'un chauffage des surfaces, d'une abrasion des surfaces et d'une application d'un apprêt sur les surfaces.

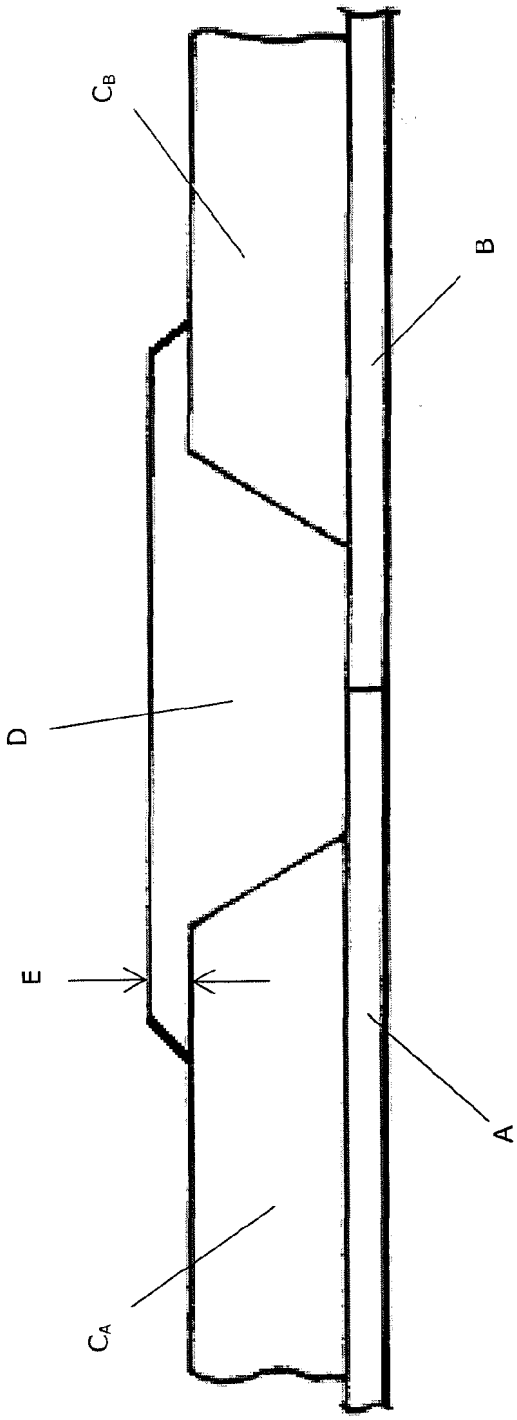

FIG. 1

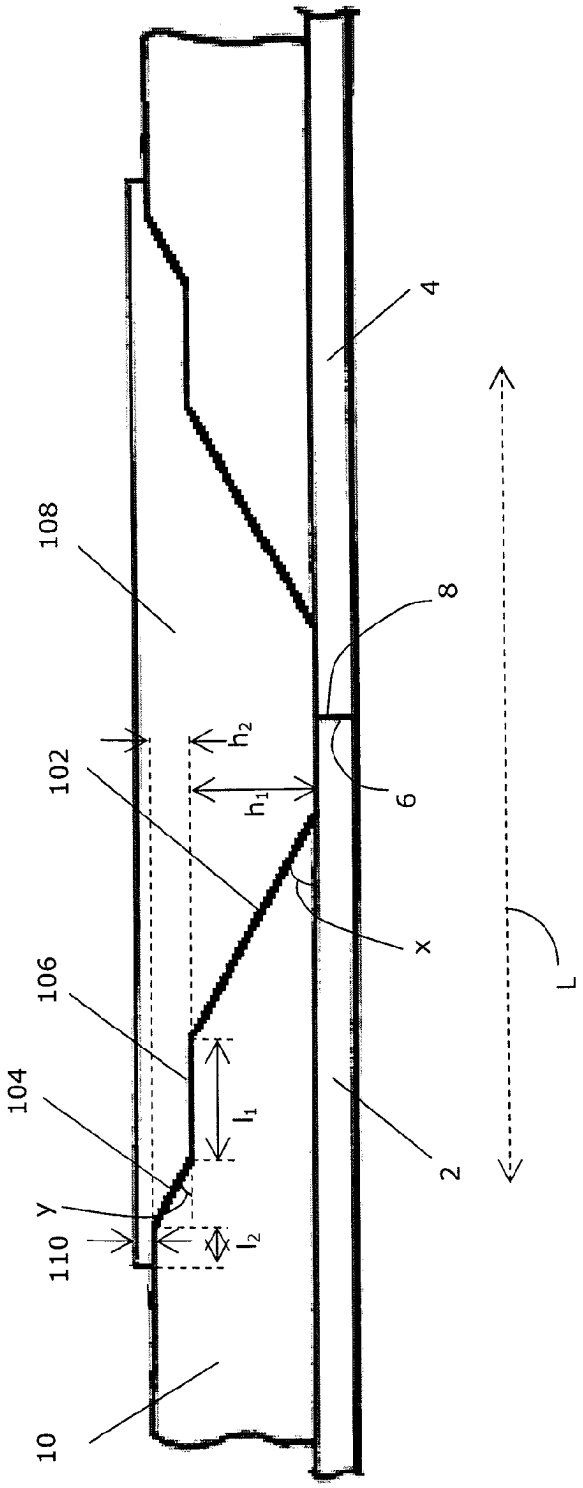

FIG. 2

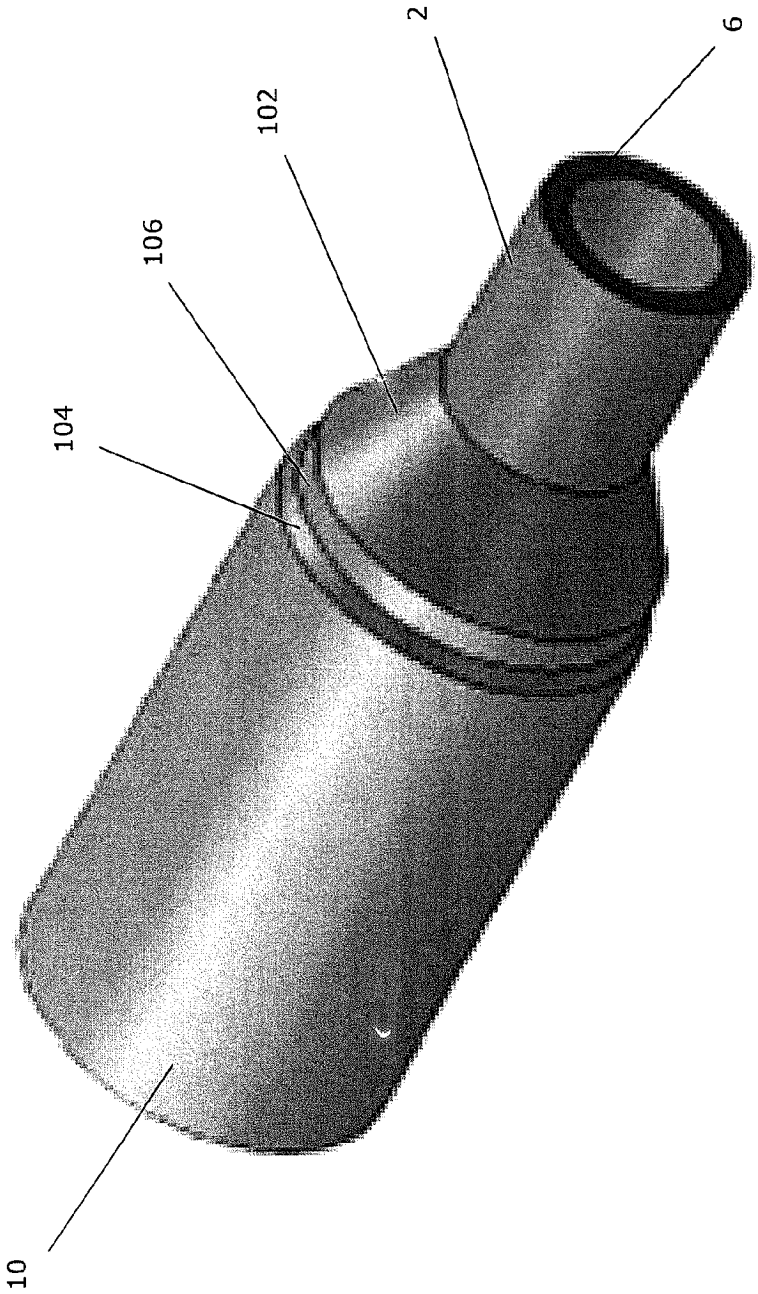

FIG. 3

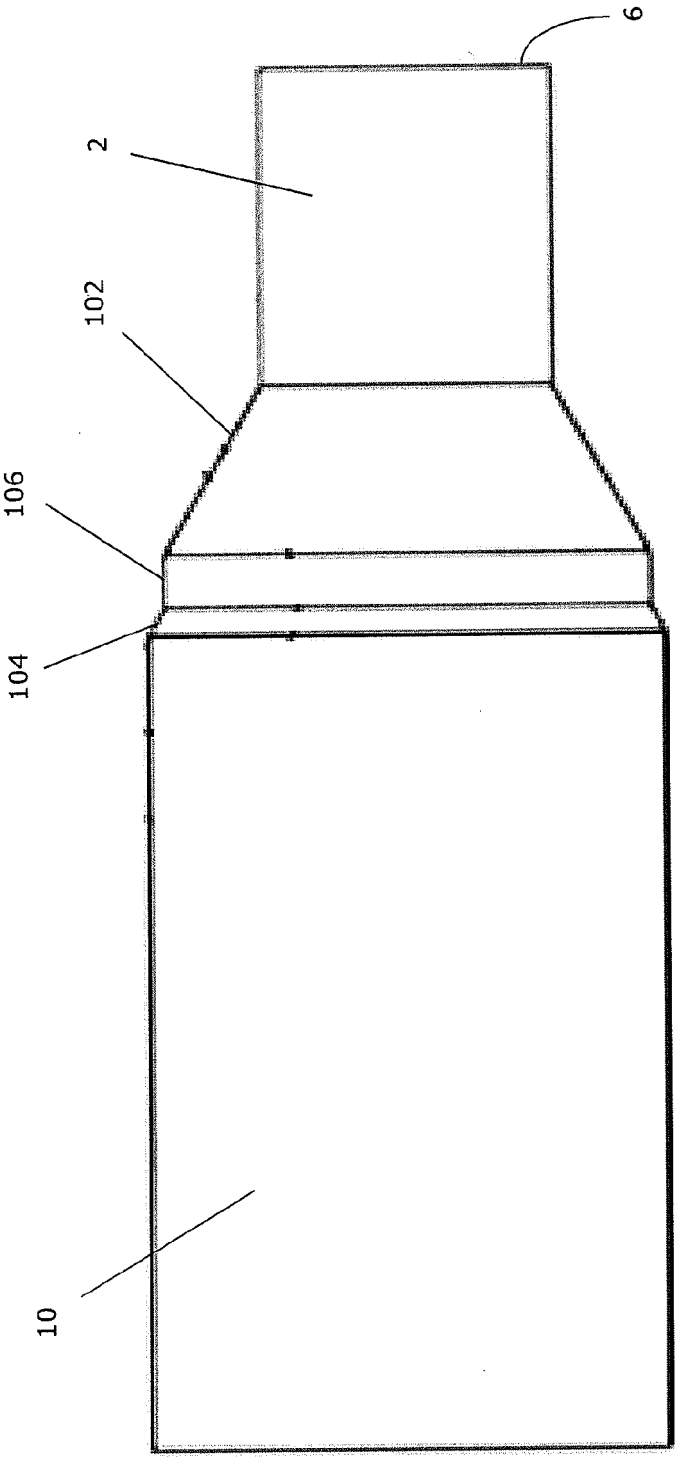

FIG. 4

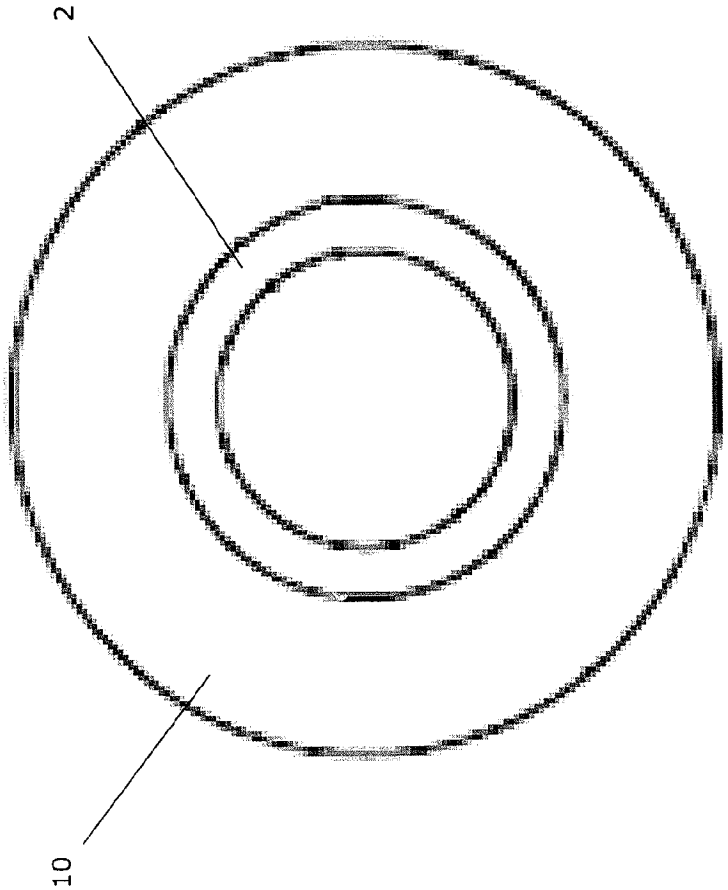

FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2012168149 A1 **[0005]**
- WO 2013066170 A1 **[0006]**